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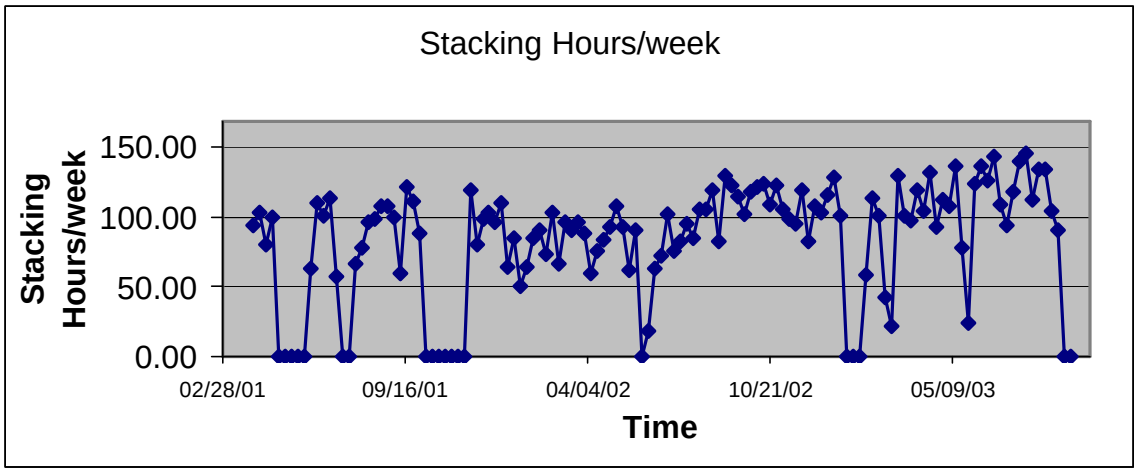
# Pbar stacking uptime

Here I am summarizing data on pbar stacking uptime, particularly focusing on the period of this year between the January and the September shutdowns. John Crawford provided me with the number of pbar stacking hours/week. This information, which is actually coming from the pbar source department, automatically takes into account downtime of Linac/Booster, Main Injector and Antiproton Source. Three factors are contributing to the downtime:

1. **Study time in MI**. This is the most uncertain to estimate, since I am not able to find any record of this. Roughly the study time amounted to no more than 10% in the last few months, since a strict control on study time was enforced. The effect of study time was larger earlier on. For the future, we should have a mechanism in place that keeps a record of the study time.
2. **Downtime due to hardware failures** in Linac, Booster, Main Injector and Antiproton Accumulator. Operators record manually the downtime of the different systems, providing both the specific reason and the duration (if it is at least 1 minute long). All the information is available both from ACNET D18 page and, more easily, from the following Web page: http://www-bd.fnal.gov/cgi-mcr/dt.pl (Shekhar pointed this out to me).
3. **Time for shots to the Tevatron.** John Crawford provided me with numbers giving the total duration of the shots. More detailed information is available in the Supertable (http://wwwbd.fnal.gov/SDAMisc/SuperTableControlNS.html), which is a collection of data from SDA.

## Antiproton stacking hours/week

The following plot summarizes the data from the beginning of Run II.



Averages have been taken over different time periods, as summarized in the following table:

| **Period** | **Average stacking hours/week** | **Uptime** |
|---|---|---|
| 2/3/03-9/1/03 | 105.79 | 63.0 % |
| 6/2/03-9/1/03 | 122.11 | 72.7 % |
| 7/7/03-9/1/03 | 118.97 | 70.8 % |

**Downtime due to Hardware failures**

Operators record manually the downtime for the different machines (Pre Acc. & Linac, Booster, Main Injector, Antiproton Source) and for two more categories:

1. ***Other systems***, which includes radiation trips for all the accelerators, power failures,… Here I went through the individual entries, including only the downtime of the machines affecting pbar stacking. A check of the individual entries shows that most of the downtime in this category is due to radiation trips in Linac/Booster.
2. ***Control system***. As above, it has been corrected to take into account only the downtime of the machines affecting pbar stacking.

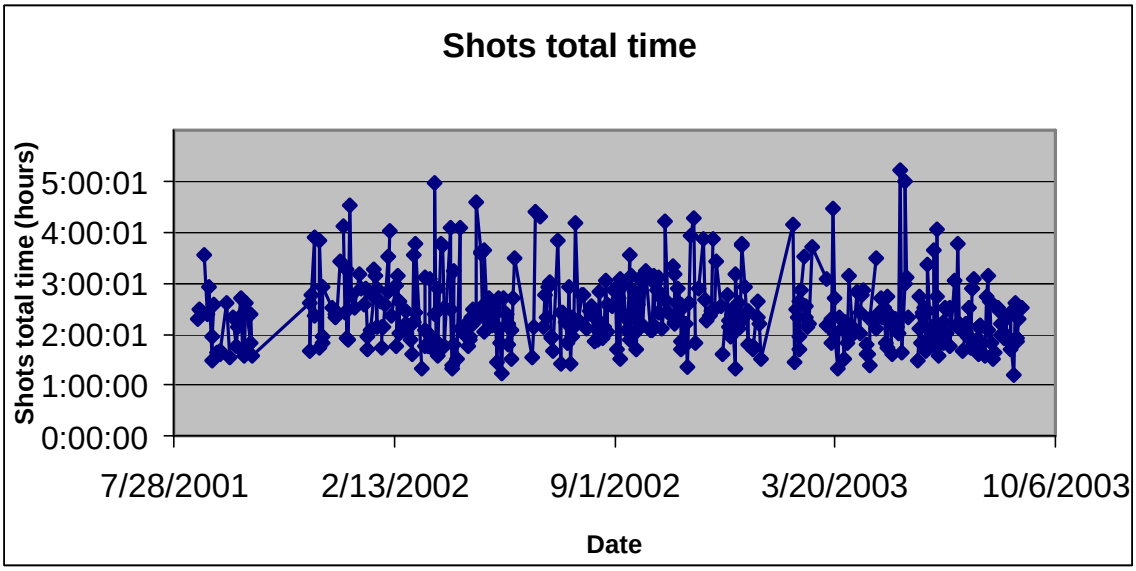
The following table shows the downtime for all the period following the January 2003 shutdown and separately for the last 2 months:

| **Device** | **downtime in the period from 2/10/03 to 9/6/03** | **% downtime in the period from 7/2/03 to 9/6/03** |
|---|---|---|
| Pre Acc.&Linac | 4.05 % | 2.71 % |
| Booster | 4.51 % | 3.05 % |
| Main Injector | 2.52 % | 3.91 % |
| Antiproton Source | 3.76 % | 2.17 % |
| Other systems | 1.73 % | 1.69 % |
| Control system | 0.36 % | 0.77 % |
| **Total** | **16.93 %** | **14.30 %** |

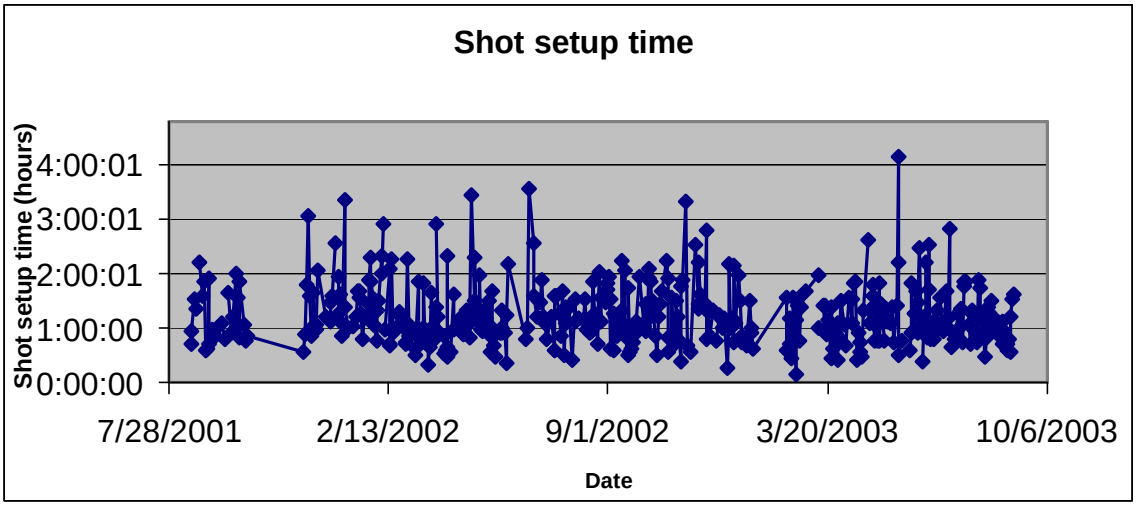
**Time for shots to the Tevatron**

This includes the setup time for the shots (tuning of the Tevatron and transfer lines), protons and pbars final loads and acceleration and beam scraping in the Tevatron. I have been collecting data for the following quantities:

1. **Shots total time**: this is the total time needed for the shots, from the beginning of shot setup in MI to HEP collisions in the Tevatron. From the Supertable data this is defined as: time(HEP) – time(start setup). Time(HEP), as I was explained by SDA people, coincides with the end of beam scraping in the Tevatron, when the Collider experiments begin integrating luminosity. During all this time, pbar stacking is not active in the Main Injector. In addition to SDA, John Crawford has provided me with the numbers manually recorded by the operators. The following plot shows the "Shots total" time throughout RunII, retrieved from the Supertable.



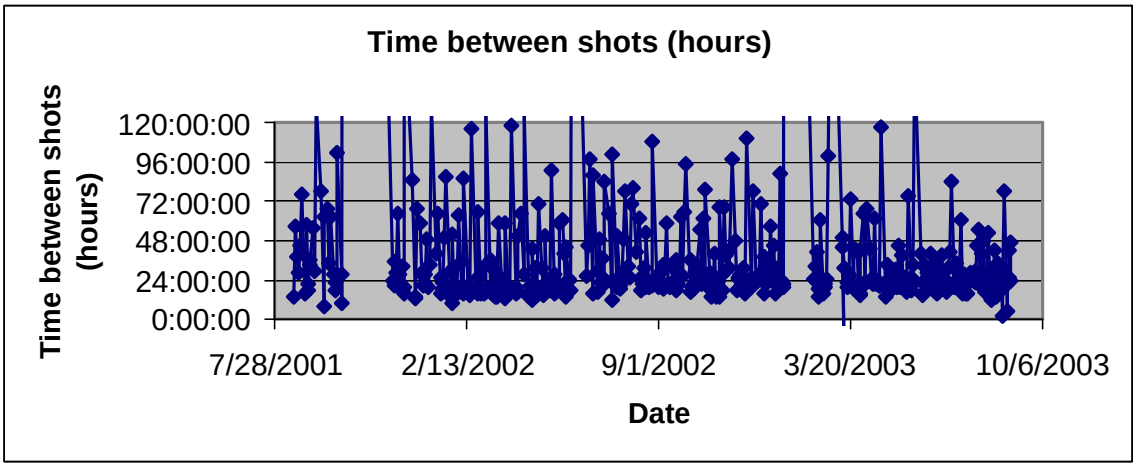

2. **Shot setup time**: this refers only to the time used to tune the Tevatron and all the transfer lines before final loads of protons and pbars into the Tevatron. It has been calculated from the Supertable as: time(startup) – time(proton load).




3. **Protons and pbars loads time and acceleration and scraping:** I do not have "measured" numbers separately for these quantities, because they are not recorded

in the Supertable. I am told that acceleration and pbar scraping in the Tevatron take about 15 minutes. Pbar stacking is restarted in MI only after beam scraping in the Tevatron, otherwise ramping of the P1 line would affect the process of scraping.

4. **Average time between shots.** This is shown in the following plot throughout RunII.




The following table summarizes average values for shots total time, setup time and time between shots.

| **Period** | **Shot total time (J. Crawford)** (hours) | **Shot total time (Supertable)** (hours) | **Shot setup time** (hours) | **Time between shots** (hours) |
|---|---|---|---|---|
| **2/10/03 - 9/6/03** | 2.58 | 2.33 | 1.18 | 31.00 |
| **7/2/03 - 9/6/03** | 2.38 | 2.20 | 1.13 | 29.07 |

I have been looking into the possibility of adding NuMI cycles during the "Shot setup" time. In this period two different supercycles are being used:

a. 35 seconds supercycle, which includes \$2B (5 sec), \$2A (10 sec), \$2D (5 sec)
b. 60 seconds supercycle, which includes \$2B (5 sec), \$2A (10 sec) and 3 \$2D (5sec each)

This doesn't leave much time for extra NuMI cycles, and the average "Shot setup" time is anyhow on the low side (4%).

**Conclusions**

A pbar stacking uptime of 71%, as measured in the last couple of months, is explained by the following downtime factors:

a. 14% due to hardware failures
b. 8% due to time for shots to the Tevatron
c. study time in MI, which in the last couple of months was kept below 10%

In the NuMI era the reliability of the machines will be harshly tested, and work will be needed to reduce the causes of hardware failures.

The addition of NuMI/SY120 cycles during the "Shot setup" time would be a complication that wouldn't gain much. Instead this time is valuable for MiniBoone. Possibilities to reduce the time necessary for shots to the Tevatron should be investigated.

Study time is necessary to make progress, but we should keep a record of it.